Bay, coloured from life. A few were also hung in each room. In the tank-room were various nets (surface, large mid-water and bottom), circular flounder-nets, mussel and other dredges, mussel and cockle implements, Italian eel-spear, hand-nets, scoops, water-telescope, thermometers (surface, deep-sea, and open-air), sieves, and various models of trawls, crab pots, &c. In the Director's room were the multitudes of preparations connected with the life-histories of the food fishes, rare pelagic forms, such as the larval *Polygordius*, *Mitraria*, *Tornaria*, and the wonderful larva of *Luidia*. In the specimen-room were the type-series of the pelagic fauna of the Bay from January to December, an extensive collection of pelagic ova of fishes from various parts of the eastern and western shores of Scotland, a series of preparations connected with the life-history of the salmon, a reference-collection of invertebrates, including an interesting series of the mussels of the Eden, oysters from the Forth and from Whitstable, a series of fishes, and other preparations.

THE INSTITUTION OF MECHANICAL ENGINEERS.

ON the evenings of Wednesday and Thursday of last week, the 4th and 5th inst., an ordinary general meeting of the Institution of Mechanical Engineers was held in London, the theatre of the Institution of Civil Engineers having been lent for the purpose. The President, Mr. E. Windsor Richards, occupied the chair on both evenings.

There were three papers set down for reading, as follows:—

"Research Committee on the Value of the Steam-Jacket; Experiment on a Locomotive Engine," by Prof. T. Hudson Beare and Mr. Bryan Donkin.

"Transmission of Heat from Surface Condensation through Metal Cylinders," by Lieut.-Colonel English and Mr. Bryan Donkin.

"Breakdowns of Stationary Steam-Engines," by Mr. Michael Longridge, of Manchester.

The two first papers were taken on Wednesday, Thursday evening being devoted to Mr. Longridge's memoir.

The Research Committee on the Value of the Steam-Jacket has been in existence for a long time now, and has proved one of the least, if not actually the least satisfactory of all the research committees constituted by the Council of the Institution. Most of these committees have done admirable work, and added largely to the stock of professional knowledge and accumulated data which engineers have to draw. Steam-jacketing is perhaps the most abstruse question which has been made the subject of an inquiry, comprising, as it does, problems extending beyond engineering proper far into the province of physical science. Nevertheless, in the present day of enlightenment, with the professor so widely abroad, more ought to have been done than has been done by this committee. It would be difficult to select an engine more unfitted for making an inquiry upon as to the value of the steam-jacket than an ordinary locomotive. Its rapid piston speed—or, rather, the high rate of turning—alone is sufficient to render it unsuitable for this inquiry; but, in any case, a locomotive is the most difficult engine from which to obtain experimental data. It is an athletic feat of no mean order to take even indicator diagrams, when one has to hang on to the side of an engine travelling at a speed varying from anything up to sixty, or perhaps eighty miles an hour. Then a locomotive, even with constant train load—a condition which can hardly be ensured in ordinary work—is seldom for five minutes at a time exerting the same power, owing to varying gradient, state of the rails, and force or direction of wind—the latter a most important consideration. Steam may be shut completely off when descending a steep bank, or the regulator may be full open and link in the last notch under exactly opposite conditions. Between these two states we have all grades of linking-up, an operation which so affects the distribution of steam—compression, expansion, &c.—that one would think the steam-jacket would finally give its job up in disgust from fair despair of knowing what it should do.

The result of all this is shown in the report, which possesses the merit of being absolutely honest and straightforward. Four trial runs were made between Manchester and York during ordinary working, with its attendant stoppages and delays. The steam-jacket fitted was of a temporary nature, and the method of testing was to make one run each way with the jackets in steam, and a like number of runs with the jackets empty. Coal was weighed and feed-water measured by a Siemens' meter. Mr. Michael Longridge drew off samples of chimney gases for analysis. Jacket-water was also drawn off and measured. Speed was taken by a Boyer recorder, and the revolutions assumed from its records.

In spite of the fact that we know nothing more about the value of the steam-jacket than we did before the experiments were made, the trials added, as a by-product, something to the knowledge of railway engineers on the performance of the locomotive; but, in any case, the thanks of the Institution are due to the authors of the paper for their disinterested labours.

The second paper was a complement to the first; for the rate of transmission of heat to and through metal is the chief thing necessary to be known for determining the value of steam-jacketing of engine cylinders. The problem is a vexed one, and no inquiry yet made has taken us beyond its threshold. The authors have attacked the subject by an endeavour to ascertain the actual temperature in the interior of the metal, and by observing the exact appearance of the film of water deposited, and, further, by determining whether such a phenomenon as cloudy steam really exists. Their apparatus consisted of a strong vertical glass cylinder about $5\frac{3}{8}$ inches in diameter and $2\frac{3}{4}$ inches high. Inside this was placed a metallic cylinder. The annular space between the glass cylinder and the enclosed metallic cylinder was filled with steam, whilst through the interior of the metal cylinder an ascending stream of cooling water was made to circulate. In order to determine the thermal gradients in the metal, when its thickness allowed of so doing, the temperatures of the interior were taken in vertical holes 1/8 or 1/16 of an inch in diameter, drilled at different distances from the condensing surfaces, and filled with mercury, into which slender thermometers were inserted. Illustrations of the apparatus were hung on the walls of the theatre, and will be reproduced in the published volume of the *Transactions* of the Institution. The pressure of steam, volume and temperature, of circulating water, and other trial conditions were controlled by suitable apparatus. The first result arrived at was that the authors consider it was not possible to trace the slightest appearance of cloudiness or mist, or of water suspended in the body of the condensing steam. The water of condensation was deposited on the surfaces. A reproduction was given of a photograph of the film of water on the surface of smooth cast-iron as it appeared through the glass cylinder, the steam pressure being 20 lbs. per square inch, and the rate of condensation somewhat slow.

The velocity of circulating water varied between 0·032 and 0·415 feet per second. The different metallic cylinders tried were made from cast-iron with both rough and smooth surfaces 11/32 and 31/32 of an inch thick, copper, and brass with smooth surfaces 2/32 of an inch thick, and smooth steel 1/32 and 10/32 of an inch thick. The rate of heat transmission was found by observing the rise of temperature in a known quantity of circulating water, and by noting the weight of steam condensed. Corrections were made to allow of accidental losses. Without publishing the diagrams on which the results of the experiments were plotted, it would be impossible to give details of the observed results unless we printed the voluminous tables attached to the papers. The greatest quantity of heat transmitted per second was about thirty-five thermal units, and the least seven thermal units per square foot of internal surface of cylinder. The authors consider that the film of water deposited by condensation, and adherent to a metallic surface, resists the transmission of heat in exactly the same way as an equivalent greater thickness of metal would do. The thickness of the water films, as determined by the difference of temperature, is less on a smooth surface of cast-iron than on a rough one, and is apparently not affected by the admission of steam-jets to sweep the surfaces. There is, the paper says, no apparent difference in the resistance to transmission of heat between the surface-layer of metal and the next to it; or, in other words, there is no drop in temperature on entering or leaving the metal. The thermal gradient at any point in the metal would be uniform in a flat plate, and becomes steeper towards the interior of a hollow cylinder as the circumference diminishes. At any point on the surface of the metal next to the circulating water, the temperature, owing to an adherent film in which the thermal gradient exists, is much in excess of the mean temperature of the circulating water at the same point.

In the discussion which followed the reading of this paper,

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Mr. Longridge said that the observed result of the steam being not cloudy, all the moisture being concentrated in a film on the walls of the cylinder, would materially affect the conditions involved in passing steam from a jacket to a cylinder, as the steam would not carry condensed water with it. Mr. Halpin questioned the fact of there being no additional resistance to the transmission of heat owing to multiplication of surfaces. The authors' statements on this point are opposed to the opinions held by many engineers; and even if they are right in regard to areas absolutely in metallic contact—like floating surface plates—those perfect conditions are not present in practical engineering work.

The second evening of the meeting was devoted entirely to Mr. Longridge's paper; a most useful contribution to the *Transactions* of the Institution, although not very easy to follow without the aid of illustrations. The paper dealt with 1000 break-downs of factory engines which had come before the author's notice. These Mr. Longridge had analysed and classified in order to show which parts of the engines gave way first, and as far as possible the causes of failure were stated. In some instances the author suggested steps which should be taken to avoid similar mischances in the future. The thousand break-downs were divided into 23 groups, and these were again sub-divided into divisions. Thus there were 213 accidents due to the giving way of "valves and valve gear," and in these were included the giving way of 46 valve spindles, 24 eccentric straps, 23 rocking shafts and levers, 21 nuts, cotters, and pins, 18 eccentric rods, 17 slide valves, besides other parts of valve gear in lesser proportions. It is notable, considering how much dread some millowners have of the "clattering Corliss gear," that only seven accidents are chronicled against this method of steam distribution, especially when one remembers how largely it is now used in Mr. Longridge's district of Lancashire. Valve spindles break when screwed, and this fact leads the author very properly to exclaim against the use of V-threads. Gas threads, he says, are better; and round threads best of all. The sharp V-thread is like the commencement of a tear. Next to valve gear "spur wheels" come on the list, with a total of 124 accidents. Mr. Longridge only includes wheels on the crank shaft; if he had taken second-motion shafts, the total would have been incomparably greater. Back-lash is the most fruitful source of mishap with toothed wheels, and a most fruitful source of back-lash is placing spur gearing and rope or belt pulleys on the same shaft, when the second motion shaft is apt to overrun the main shaft. Uniform load, a heavy fly-wheel, and slow speed of ropes, are points that need to be observed in such cases. Vibration is also a frequent cause of accident with spur gearing. Machine-moulded teeth are best, and it is desirable to carry the toothed quadrants on the arms of the fly-wheel rather than have teeth on its periphery. Air-pump motions are next; they caused 121 breakdowns. The chief heading in this division is "weakness, wear and tear, or neglect"; causes which speak for themselves.

Air-pump buckets and valves were responsible for eighty-eight out of the thousand accidents. These mishaps were mostly due to the giving way of parts, foot-valves being the chief delinquents. In reference to accidents through broken packing rings in buckets, the author said he would as soon have plain buckets, packing rings being "expensive, dangerous, and entirely useless." One speaker, Mr. Saxon, who himself has had considerable experience with mill engines in the same district, agreed with the author in regard to low lifts, but if a high lift were required, he considered packing necessary. "Columns, entablatures, bedplates, and pedestals" accounted for eighty-six break-downs. The settlement of foundations is the most frequent cause in this division, and the author warns engineers against setting-up holding-down bolts in columns when the masonry settles, as this naturally brings undue stresses upon the structure of the engine. The difficulty is that engineers very often do not recognise that the masonry foundations are settling when a column becomes loose on its seating. The chief cause of the decay of foundations appears to be the deterioration of stones and cement or mortar by oil getting to them. One speaker during the discussion—Mr. Rounthwaite, a marine engineer—asked why the designers of mill engines were so fond of brick-work, and suggested that it would be preferable if very deep cast-iron bedplates were used so as to reduce the masonry required. The author said that the gradual spread of the vertical or inverted type of engine facilitated the use of deeper metal bedplates. The horizontal engine had held its position so firmly because it gave a long stroke, but with the speeding up of mill machinery, characteristic of modern practice, a higher rate of revolutions was required, and this made shorter stroke engines preferable, so that the vertical type was gaining ground. Main shafts were the cause of forty-nine accidents, some of them the most interesting of the series. By far the greater number of shafts that broke down gave way through wear and tear. One veteran made 176 million revolutions before being taken out, owing to a mysterious grooving under an eccentric sheave. A Whitworth fluid-compressed steel shaft gave poor results, running only 61½ revolutions, and giving way under the low stress of 4600 lbs. per square inch. This single case, however, will not be sufficient to destroy the high reputation of Whitworth shafts. Connecting rods, of which forty-one gave way, break almost invariably in the connections, gibs cotters, open-ended straps or bolts giving way; one instance of a body failure, through an imperfect weld, alone being recorded, although there were six failures of forked ends. Cylinders and valve chests, with which there were thirty-five accidents, mostly break on flat surfaces, covers, or doors; the presence of water being the chief cause. Parallel motions account for thirty-five breakages, mostly in eye shafts. Governors supplied twenty-eight accidents to the list, and piston-rods twenty-seven; cotter-holes being again the weak point. The author very rightly warns designers against abrupt changes of section in piston-rods, for though the average draughtsman appears to be quite alive to this evil in regard to castings, yet he often appears to think it produces no bad effect where the effects of unequal cooling are not to be anticipated. Piston-rod crop-heads afford twenty-seven examples of break-downs, mostly from "wear and tear"; the giving way of pistons supplies an equal number of mishaps, whilst the breaking of links contributes twenty-one accidents towards the total.

Nineteen break-downs of fly-wheels are recorded, the chief cause being internal stress—due presumably to ill-proportioned castings—whilst eight bosses were cracked, five by driving keys too hard. The author made some pertinent remarks on the question of keying fly-wheels on to shafts, describing the Lancashire method of "staking," which is the best plan for giving a true running and rigidly secured wheel without straining the boss. Mr. Holroyd Smith, in the discussion, sketched an improved form of key which appeared to be designed on sound principles. Air-pumps and condensers gave way thirteen times, gudgeons in beams twelve times, and cranks twelve times. Of the latter eleven were of cast-iron, so there is not much need to comment upon them. Eleven crank-pins broke; in one case a Whitworth steel pin gave way through the skin being injured by shrinking in the crank web. The tear being started, failure was but the result of time. There were only six instances of broken engine beams. One the author attributes simply to fatigue. The engine was made in 1847 and worked until 1892, when some fine cracks were noticed near the middle of the beam, which was of cast-iron. These cracks developed, extended, and joined up, so that the beam was condemned. Prof. Hudson Beare joined issue with the author on the propriety of attributing the failure of this beam to fatigue. He said that once the original crack was set up, the beam was in a less advantageous position to bear the load put upon it, so that the crack would be further developed until it finally succumbed.

The remaining causes of accident were failures of slide-bars five, and of ropes three; whilst an "entire smash," no cause ascertained, completes the roll of a thousand break-downs.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

Cambridge.—The following science teachers in the University were, on November 7, elected members of the Council of the Senate: Alex Hill, M.D., Master of Downing, and University Lecturer in Advanced Anatomy; R. T. Glazebrook, F.R.S., Assistant Director of the Cavendish Laboratory; and A. E. Shipley, University Lecturer in the Morphology of Vertebrates, and Secretary of the Museums Syndicate. Dr. R. C. Jebb, M.P., and Dr. J. N. Keynes, Secretary of the Local Examinations Syndicate, were also among the successful candidates.

The Professorship of Surgery has been again suspended until the first day of next term, to give time for the further consideration of the stipend and conditions of tenure. It appears

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